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MEDICAL AND SOCIAL ASPECTS OF FLOODS AND THEIR MEDICAL RISK MANAGEMENT

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Key words: flood, calamities, victims, medical management.

Introduction. Currently, there is a steadily increasing trend in losses due to flooding. Nevertheless, global warming, followed by an inevitable overuse of river valleys might further contribute to an increase in the frequency and destructive power of floods. It is quite important to trace the cause and effect chain of the economic, social and ecological impacts during the flood hazard.

Material and methods. A bibliographic research was carried out by using historical and descriptive methods based on the keywords, underlining the medical, social and economic significance of the present issue.

Results. There are 57 natural lakes and about 3 400 artificial water reservoirs found on the territory of the Republic of Moldova, including 90 amounting to over 1 million m³ per each. The accumulation basins help in preventing and combating overflows and flooding during spring and summer periods. Most of the dams do not comply with the technical norms, as they do not have channels of respite and drainage, thus, a dam failure on top dike might generate the collapse of the others at the lower watercourse, resulting in disastrous consequences. Therefore, individual health protection measures and appropriate population behavior are vitally important in catastrophic floods.

Conclusions. Over the last decades, the floods occurring in the Republic of Moldova have conditioned the need to increase interventions for prevention and reduction of both economic and human losses both at national and international levels.

Cuvinte cheie: inundații, calamități, victime, management medical.

ASPECTE MEDICO-SOCIALE ALE INUNDAȚIILOR, MANAGEMENTUL MEDICAL ȘI AL RISCURILOR

Introducere. În prezent, există o tendință de creștere a prejudiciilor provocate de inundații. În același timp încălzirea globală a climei și creșterea inevitabilă a vânturilor și a vărilor râurilor va contribui pe viitor la creșterea frecvenței și puterii distructive a inundațiilor. În timpul inundațiilor, este importantă constituirea lanțului cauză-efect a consecințelor economice, sociale și ecologice.

Material și metode. Au fost studiate surse bibliografice care redau informații ample cu referire la inundațiile ce au avut loc în Republica Moldova și în regiunile din vecinătate.

Rezultate. Pe teritoriul Republicii Moldova sunt amplasate 57 de lacuri naturale și circa 3400 de rezervoare artificiale de apă, inclusiv 90 cu un volum de peste un milion de m³ fiecare. Lacurile de acumulare servesc pentru prevenirea și combaterea revărsărilor și inundațiilor în timpul viiturilor de primăvară și vară. Barajele multora din ele sunt construite fără respectarea normelor tehnice, nu au canale de degrevare și scurgere, de aceea ruperea unuia, în partea de sus, generează ruperea celorlalte din cursul inferior, urmările fiind catastrofale. O importanță deosebită în inundațiile catastrofale au măsurile de protecție medicală individuală și comportamentul corect al populației.

Concluzii. Inundațiile din ultimele decenii în Republica Moldova au condiționat necesitatea intensificării activităților de prevenire și minimizare a consecințelor materiale și umane, atât la nivel național cât și internațional.

INTRODUCTION

Humanity faced flooding since ancient times, a fact confirmed by the biblical Great Flood. According to Robert Ballard, a marine explorer, there is an evidence of a catastrophic flood that happened 7500 years ago in the Black Sea at about 170 meters deep that is possible effects of "Noah's Flood".

Floods are both natural disasters and technological and social phenomena (1), considered the most widespread hazard on earth. According to the Centre for Research on the Epidemiology of Disasters of the Catholic University of Louvain (Belgium), they make up 37% of the total number of natural hazards resulting in severe outcomes and extremely severe human losses with considerable economic damages, followed by negative economic, social and ecological impacts (2, 3, 4).

The study analysis of the floods throughout the last century confirms a steadily increasing tendency of damages caused by floods worldwide, one of the main causes being the irrational use of the river valleys and the increase of the economic activity in risk-prone areas (5). Nevertheless, global warming and the inevitable overuse of river valleys might further contribute to an increase in the frequency and destructive power of floods. Floods can be caused by natural phenomena such as: water flows (flash floods, clogging of the running water streams and sloping into the riverbed, crowding of glaciers or other floating objects in narrow curves or sections, the increase of the sea or ocean level in the area of the watercourse overflow due to high tides or strong winds); rain or stagnant melting snow, dripping from the slopes; an increase in groundwater level due to high infiltration rates; hurricanes or typhoons; and submarine volcanic eruptions. Floods triggered by accidental scenarios are due to a dam failure and collapse or other hydrotechnical constructions, as well as due to inappropriate and non-compliant actions related to the hydrological situation at the water drainage systems and sudden sliding slopes into the accumulation basins.

The human-induced floods occur due to the overfilling of the artificial basins, the deliberate cutting of the dam defense structures, inadequate irrigation system performance, characterized by great water loss with no proper drainage measures, and earthquake-triggered floods due to accumulations (6).

MATERIAL AND METHODS

The purpose of the bibliographic study was to underline both the medical and social aspects and flood-health risk management. The studied bibliographic sources provide ample data on floods occurring both in the Republic of Moldova and in the neighboring regions. A bibliographic study was carried out by using the historical and descriptive methods based on the keywords, emphasizing the medical, social and economic impacts of the present problem.

RESULTS

Catastrophic floods make up about 33-35% of total floods. They can result from heavy rainfalls; overflow of accumulation basins of hydroelectric stations and lakes; sudden melting of snow and glaciers; and coastal water waves and tsunami. Dam and levee failure might cause landslides and earthquakes, etc. The size of the flood outbreak depends on the amount of water, the affected area and the rainfall duration and intensity.

There are several types of floods depending on their triggering factors and the flood-affected areas. The most commonly occurring floods are as following (7,8):

- fluvial flooding is the overflowing of water body, generated by a high flow over the boundaries of the minor riverbed to the major one due to several causes, such as: heavy rainfall, an increased water level, resulting from the degradation of the riverbed by alluvium, ice blockages, dam and levee collapse etc.;
- coastal flooding might affect the coastal areas, caused by strong storms, which trigger large wind waves that might sometimes lead to a dam failure and storm surges, magnified by rising sea levels. Depending on the generating factors, coastal areas might be flooded with salty or brackish water;
- urban flooding occurs due to improper sizing or poor maintenance of urban drainage systems, which cannot provide a proper rainwater runoff during heavy rainfall episodes.

Other types of floods occur due to accumulation of the running water in the low-lying areas at the base of the slope and because of groundwater excess (in areas where groundwater is close to the topographic surface).

The most severe floods that have caused major human losses were as following:

China (1931) – 3,700,000-4,000,000 victims,
China (1887) – 900,000-2,000,000 victims,
China (1938) – 500,000-700,000 victims,
China (1975) – 231,000 victims,
Indonesia (2004) – 230,000 victims,
China (1935) – 145,000 victims,
Vietnam (1971) – 100,000 victims,
China (1911) – 100,000 victims.

The Republic of Moldova has 57 natural lakes and about 3400 artificial water reservoirs, including 90 with over one million m³ per each (3, 10). Accumulation basins might prevent and combat overflows and floods during spring and summer seasons. The largest storage tanks are found in Costinesti Stînca (735 mln m³), situated on the Prut river and in Dubăsari (277.4 mln m³), on the Dniester river. Most dams do not comply with normal technical standards and do not have respite and drainage channels, thus, a dam failure on top dike might generate the collapse of the others at the lower watercourse, resulting in disastrous consequences. In 1991, the heavy torrential rains led to catastrophic floods in Șoldanesti, Orhei district. As a result, 21 people died, 8 thousand houses were damaged, of which 516 were completely destroyed, and 400 thousand ha of agricultural land was flooded. In 1994, the Republic of Moldova experienced one of the most unfavorable episodes throughout the last century (11).

On August 26-27, 1994, the downpour intensity was over 40 mm/hour, accompanied by strong winds and hail, which caused enormous damage (\$ 100 million) and human comorbidities (29 people).

Over the last years, the major floods occurring on the territory of the Republic of Moldova were on June 16-17, 2003 and on August 7, 18-19, 2005, being caused by heavy rainfalls. These led to stream flows, as well as the formation of intensive leakage from the slopes, causing huge financial losses within different national economic sectors. The total land area of the Republic of Moldova, which are periodically flooded makes up about 20% of the entire country's surface or more than 600 thousand ha (3, 11).

At the end of May and the beginning of June 2016, following the heavy lasting downpours across Central Europe, the floods affected dozens of locations in Austria, Belgium, France, Germany, the

Republic of Moldova and Romania (1). On June 1, torrential rains caused massive flooding in the Republic of Moldova. A great number of streets and basements of flat blocks were flooded in Chisinau, including Albisoara Street, where the water was over one and a half meter high due to the sewer system failure. 200 houses were flooded in Iargara village, Leova district. The water flooded into the courtyards and borderlines of dozens of houses in Logănești, Hîncești district (6).

In June-August 2008, the Ukraine, Romania and the Republic of Moldova were hit by one of the worst floods over the last two centuries. In July 22-28, 2008, in Western Ukraine, where the Dniester and Prut upper courses are located, the amount of precipitation was 63-260 mm, which is 1-3-month norm fell. In the third decade of July 2008, precipitations fell everywhere on the territory of the Republic of Moldova. The largest amount of precipitation during the decade, was 225 mm in Ocnița, exceeding 10 times the de-cade normal amount, which was first reported during the entire period of instrumental measurements. In the northern and in some of the central and southern regions of the republic the amount of precipitation per decade made up 85-185 mm or 440-800% of the decade norm. The remainder of territory amounted precipitation of 15-70 mm or 100-420% of the decade norm. As a result, the floods occurring during the period from July to August 2008 on the Dniester and Prut rivers were historical flash floods (6, 11, 12, 13).

It is crucial to establish the cause and effect chain during flooding while considering the following aftermath (13, 14, 15, 16):

- economic destruction or damage of: industrial buildings, roads and railways, locations, oil, water or gas system supply, electrical and telecommunications lines, bridges and culverts, and the zootechnical sector;
- negative social impacts: human comorbidities, people evacuation, risks of epidemics, educational process disruption, damage to cultural assets, panic disorder, reducing the disaster rate of flood-affected areas and income of the population;
- negative ecological consequences: environmental degradation, pollution of the surface or groundwater, soil pollution, excess humidity, slope degradation, destruction of fauna and flora.

Additionally, to the direct effects, there is a number of indirect effects that might interrupt the manufacturing processes, delay goods delivery, trigger expenditures for defense works and for normalization of life after floods, as well as reduce exports.

Most floods might lead to considerable financial and human losses, being termed as catastrophic flood events, faced by a community or region. For a better objective determination of financial and human losses, the territory is divided into four flood zones with the following determinants: the height of the water level, the flood onset, the water drainage velocity and the flooded surface area (17).

The catastrophic floods occurring on large areas might influence the strategies of the health and civil protection bodies and the healthcare services of the Ministries and Departments of defense appropriations for liquidation of disaster consequences, as well as on the organization and use of the trained forces and means of medical assistance. In these cases, great attention is paid to the flooded land surface, since the population might be deprived of sheltering, food and water supply, as well as of medical or social assistance that should be commonly provided during the first flood hours (hours, days). The population in this area might be subjected to the action of low-temperature water, winds, air humidity and other meteorological factors (18).

A series of factors might influence the volume and structure of health losses in catastrophic flood outbreak, such as: timely notification of the population in the area at risk of flooding; the degree of preparedness for people evacuation; the population density in the risk-prone areas; the building patterns; the day time (night, day); season; the distance between different locations (village, city) and the dams; the flood wave height and duration, water temperature; exacerbation of area – based socio-economic status (19).

The efficiency of medical assistance and the use of the trained forces and means of emergency healthcare services will increase considerably, if the flood outbreak is divided conventionally into four zones (9). The volume and structure of the health losses (tab. 1) vary depending on the speed of the water, the height of the water wave, the distance from localities to the hydrological object with flood phenomenon (typhoon, tsunami, disturbances of the sea, the ocean, etc.) The amount and structure of the health losses (tab. 1) vary according to water velocity, water wave height, the distance between the locations and the flood-related hydrological objects. (typhoon, tsunami, sea and ocean disturbances, etc.)

The volume and structure of the health damages (tab. 2) will differ in different floodplains depending on the day and night time.

Table 1. Characteristics of flood pains.

Flood plains	Distance between the dam and water wave	Water wave height	Flow velocity	Wave duration
I. Catastrophic flood	6-12 km	> 3 m	> 30 km /h	30 min
II. Fast flow	15-20 km	1.5-2 m	15-20 km/h	50-60 min
III. Medium flow	30-50 km	<1 m	10-15 km / h	2-3 hours
IV. Slow flow (overflow)	36-70 km	-	6-10 km / h	5-6 hours

In order to eliminate the catastrophic effects of floods, the local healthcare services (civil protection, the Ministry of Health, Labor and Social Protection) develop early health-action planning for medical assistance of the population and the affected – area victims.

The presidents of the commissions for exceptional affairs will administer the Special Forces and the emergency medical assistance services that help in evacuation and rescue of the population, and who otherwise administer the local institutes, dis-

trict and republican medical establishments.

It is highly important to be aware of the sanitary and epidemiological conditions of the risk-prone areas for the liquidation of the aftermath calamities, it might worsen due to the destruction of the water supply and sewerage systems, the pollution of the wells etc.

Wastes and garbage that spread to other neighboring places might pose a threat on spreading infectious morbidity within the affected floodplain.

Overcrowding of people on a small area, as well as exacerbation of the social and economic status can also cause an outbreak and spread of communicable infections and zoonotic diseases (decay of animal bodies and rodents).

Additionally, to civil protection and Ministry of Health, Labor and Social Protection means, the liquidation of aftermath catastrophic floods will

require medical services of the Armed Forces, according to the relevant directive documents, available in the National Army and documents, regulating medical assistance under exceptional circumstances. Specially trained teams will provide premedical aid (paramedics) and first medical aid (doctors) during the outbreak.

Table 2. The characteristics of the losses within the flood plains (in %, according to the number of population in the flood-affected areas).

Flood plains	Overall losses		Out of the total loss amount			
	day	night	Irretrievable losses		Health losses	
			day	night	day	night
I	60.0	90.0	–	–	–	–
II	13.0	25.0	10.0	20.0	90.0	80.0
III	5.0	15.0	7.0	15.0	93.0	85.0
IV	2.0	10.0	5.0	10.0	95.0	90.0
Mean loss value	20.0	35.0	15.0	30.0	85.0	70.0

Persons joining the immediate rescue operations of the victims must be well trained and provided with various salvation (belts, circles, lifejacket) and floating means (boats). Emergency medical assistance brigades (paramedics and doctors), mobile detachments of the Ministry of Health, Labor and Social Protection, as well as Ministries of Armed Forces and Civil Protection will also be activated during the outbreak.

Specially trained teams and health-epidemic assistance brigades from various preventive medicine centers (district, city, republican) will be provided for flood-affected areas.

In many cases, flooding can be a very serious testing of the community's responsiveness. The ability and capacity to effectively cope with a flood has become increasingly relevant nowadays due to a higher-risk flood tendency, especially in recent years.

The major objective of risk identification refers to flood risk management (20). It determines the application of policies, procedures and even practices that would tend towards this objective. The flood risk management is aimed at analysis and assessment, treatment, monitoring and re-assessment of risks in order to reduce them, so that human communities and all citizens would survive, work and meet their needs and aspirations within a sustainable physical and social environment.

The experience of Moldova on the reduction of

negative flood aftermaths in small river basins, indicates that the optimal economical effect can be achieved when applying both the passive methods (digging, forest improvement works, etc.) and the active methods of protection by regulating the water flowing into a system of maximum water storage capacity tanks, followed by a subsequent water evacuation amounted at a 1-3% insurance volume (19).

The planning schemes for flood mitigation works in the river basins consist of correlative and cumulative effects of the following works: embankments, works for the regularization of the riverbeds, non-permanent accumulations and polders, permanent accumulation basins provided with volume-control storage to mitigate floods.

The first stage on reducing floods by embankments was actually a mistake because it eliminates the natural effect of mitigation of meadows and leads to the increase of maximum overflows. As the lower sectors of the large watercourses are embanked, new embankment works should be avoided without being compensated in the accumulation basins or into polders.

Although most of the extreme phenomena cannot be completely overcome yet, a prior knowledge on the area patterns and the possible intervals between the disaster episodes would significantly reduce their destructive impact (21). Farmers should be aware and familiar with the achievements of modern science, as well as timely access

of qualitative forecasting services, which would ensure a considerable increase in the productivity of agricultural crops, by significantly reducing the losses and negative consequences of various natural hazards.

Currently, the perfection of the long-term weather forecasting methods on negative phenomena occurrence has become vitally important for the Republic of Moldova since both the amplitude and the incidence rate of the natural disasters have obviously increased over the last years. This step can be defined and highlighted as regional trends of climate change and variability that refers to long-term climate predictions, being categorized as more qualitative, rather than quantitative ones (including the daily weather forecasts) (22, 23).

In order to reduce the risk of flooding, the following measures are recommended:

- Mapping of the land surfaces and river course that are mostly exposed to flooding, as well as the quasi-horizontal surfaces of the plains, where the water can stagnate during periods of excess humidity.
- Overall embankment works of the major riverbeds and meadows, as well as polder formation should be avoided in order to provide “breathing” spaces during flood periods.
- Anti-erosion works in the accumulation basins should be carried out, as well as the unclogging of minor riverbeds.
- Any kind of construction near the minor riverbeds, which are at risk of flooding and are marked red, should be prohibited. Strong involvement of local and national authorities regarding the environmental protection is required, in order to apply flood prevention measures to protect the population and environment.
- Information system efficiency regarding the warnings for hydrometeorological hazards.
- Education of the population on the protection of the riverbeds from solid wastes pollution.

The Republic of Moldova has developed the “Regulation on Flood risk Management” that provides (24):

- Normative framework for flood risk management.
- Preliminary Flood Risk Assessment.
- Flood hazard and flood risk mapping.
- Flood Risk Management Planning.
- Public consultations and plan approval and revision.

- Reports on implementation action plans.

The measures on population individual health protection and appropriate behavior is of particular importance in catastrophic floods. Prior to a flood episode, the population should be trained and urged to follow and carry out certain recommendations:

- To show interest in the possible local floodplains, found at the town halls.
- To avoid building houses nearby the risk-prone flood areas.
- To use waterproof walls for the basements in order to prevent water flow.
- To build barriers to prevent water from flooding into the houses.
- To clean the ditches and storm sewers, to prevent clogging of the rainwater.
- To safely dispose the household waste and vegetable debris not to contaminate the running streams.
- To prepare the emergency backpack in advance.
- To participate to simulated emergency exercises organized by emergency professional services and local authorities.
- To learn about the warning alarm signals and the evacuation procedures.
- In case of imminent flood risk, to turn off the heating, gas and electricity devices.
- To place the toxic substances in a safe place so as to avoid pollution.

In case of flooding:

- To stay calm.
- To warn the neighbors and support the disabled people, children and the elderly.
- To be aware about the danger and its evolution.
- To use the phone only in emergencies as not to overload the network.
- To follow the radio or television broadcast recommendations given by the authorities.
- In case of evacuation, to move towards an immediate or nearby high level area, specified by the authorities; in case of flash floods, people should move up towards the upper parts of the house or on the roof, until the rescue teams arrive.
- To move the essential objects to the upper floors of the house, if there is enough time.
- To disconnect the general power switch. To disconnect all the electrical devices. Not to touch the electrical devices if they are dirty or in water.

- To switch off water and gas supply systems.
- To evacuate animals and valuable assets into specific prior- established refuge places.
- To avoid moving through the water flows, as people might lose the balance in about 15 cm high waters.
- To avoid traveling by car across the flooded area: in case of about 20 cm of floodwaters, water may enter the vehicle, resulting in loss of control. At about 40 cm of floodwaters, the vehicle starts floating. In 60 cm of water, most vehicles are carried away by floodwater.
- To be prepared of quick evacuation at short notice of those in charge of rescue operations.
- To use the itinerary indicated by those in charge.
- To avoid shortcut pathways as not to get into a dangerous place.
- To take only the strictly necessary belongings (identity documents, medicines).
- To avoid using the electricity, water, gas supply equipment unless specialized services approve.
- To clean and disinfect all objects that have been in contact with floodwater: there is a life-threatening situation of disease contamination due to the lack of hygiene and the affected sewers.

If any suspicions arise regarding the contamination of the drinking water, bottled or boiled water should be used.

Prevention and reduction of the negative effects, as well as disaster preparedness, including flooding are crucially important issues and policies promoted by the World Health Organization (25, 26) – a specialized agency within the United Nations that is responsible for coordinating global health problems. Another key aspect of the “One health” approach concerns the need to include the health institutions, all the available private sectors, the military medical services, etc., within the planning process. Risk reduction and emergency preparedness are the responsibility of all national actors. At the national level, the Ministry of Health, Labor and Social Protection is the leading agency responsible for the healthcare sector, which apart from the medical services of the Armed Forces, includes the Red Cross society, the non-governmental healthcare organizations, the private health facilities and professional associations. Emergency preparedness requires a multi-sectoral approach. This approach might be applied to all types of emergencies and crises including those of health origin such as major epidemics, food poisoning, waterborne diseases or toxic chemical leaks and spills.

After the flooding:

- To help the injured.
- To listen to local authorities regarding the information on the local drinking water supply.
- To avoid areas with still water: the water may be contaminated with gasoline, diesel or sewage debris; it can also be electrically charged with high-voltage power lines or grounded electrical cables.
- To avoid water currents.
- To learn about the water withdrawal areas: roads or bridges may exhibit low resistance and collapse due to vehicle overloading.
- To be careful when entering the flooded buildings since their resistance might be affected, particularly the foundations.

CONCLUSIONS

1. Floods remain some of the most frequent and powerful natural phenomena that have aggravated the situation of many countries, including the Republic of Moldova, especially in the last decades and have conditioned the need to increase interventions for prevention and reduction of both economic and human losses both at national and international levels.
2. While assessing the tremendous increase in direct flood damages, the expenses involved in their liquidation and rehabilitation of the affected population, as well as the experience of the developed countries worldwide, we can conclude that the problem of the flood risk management requires enormous financial costs that show an unprecedented growth rate along with the increased level of security.
3. The major purpose of the health care system, while liquidating the medical flood consequences, is to provide primary emergency medical care to the injured, according to the medical indications and to evacuate people safely to health-care institutions away from the flood outbreak.
4. Since floods, particularly the catastrophic ones, lead to a sudden exacerbation of the sanitary-hygienic and anti-epidemic status within the flooded areas, medical assistance to the injured, along with sani-

tary-hygienic and anti-epidemic measures should be necessarily carried out by both the regional and national health care systems, for the purpose of maintaining the health status of the affected population as well as to prevent the occurrence and spread of infectious diseases.

CONFLICT OF INTERESTS

All authors declare no competing interests.

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